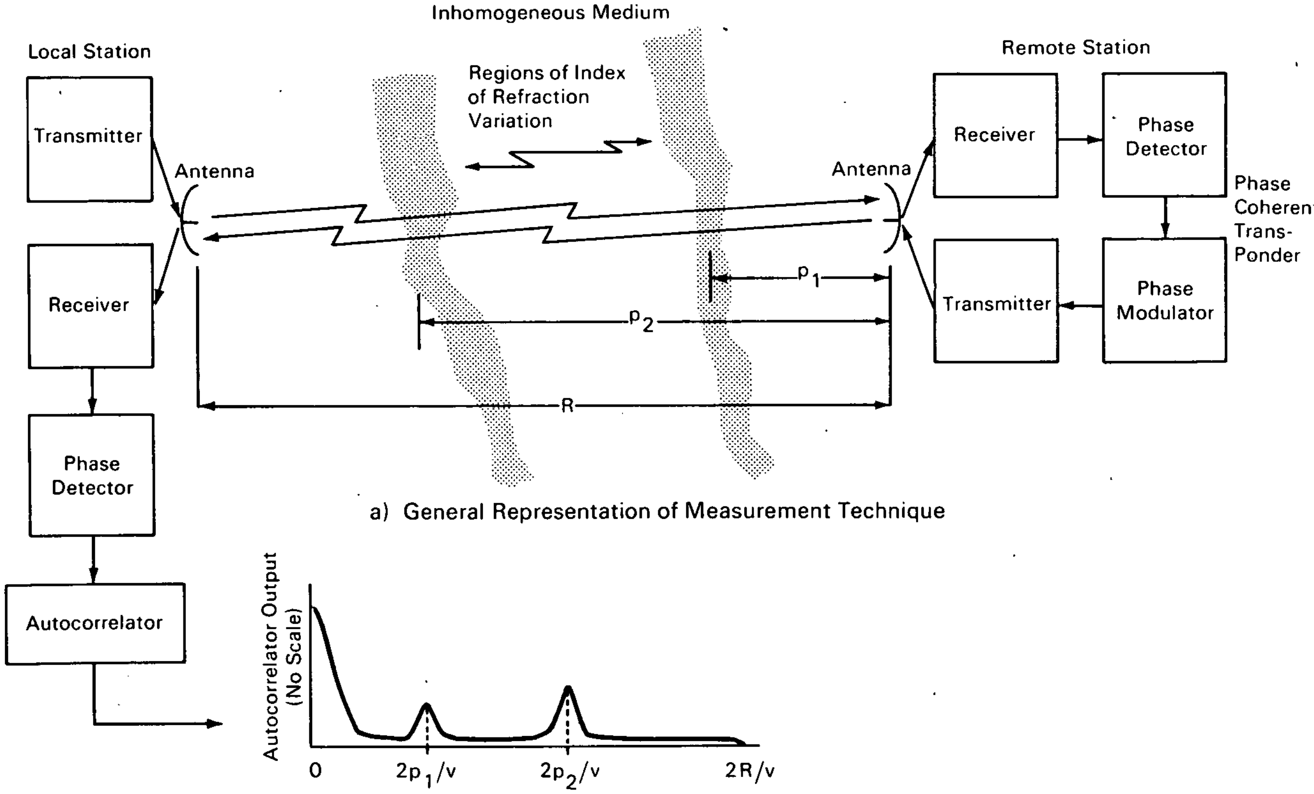
NASA TECH BRIEF

General Technique for Measurement of Refractive Index Variations



a) General Representation of Measurement Technique

b) General Appearance of Autocorrelator Output for the Above Situation

The problem:

To measure the characteristics of random, time varying, inhomogeneous regions in a propagating medium by means of traveling electromagnetic or acoustic waves.

The solution:

Both amplitude and phase fluctuations are impressed on any wave propagating through a medium which has a randomly varying refractive index. The time variation of these fluctuations may be used to examine isolated

(continued overleaf)

regions along the line of propagation. A general technique has been derived for measuring the location of the regions of refractive-index variation and mapping the magnitude of the variation versus distance along the propagation path. The technique is unusual in that only one antenna is used at each end of the line.

How it's done:

As shown above, a radar transmitter and a receiver are stationed at both the local and the remote ends of a line, providing two simultaneous transmission links. Both links traverse the inhomogeneous region to be investigated. As the uplink (local-to-remote) wave passes through regions of index of refraction variation, both phase and amplitude modulation are impressed on the carrier wave. At the remote station, which is configured as a phase-coherent transponder, the phase modulation of the received uplink carrier is detected and immediately remodulated on the downlink (remote-to-local) carrier.

As the downlink radiation passes back through the inhomogeneous region, the same phase and amplitude modulations are reimpressed on the carrier, but delayed in time by an amount $2p/v$ where p is the distance from the inhomogeneity to the remote station (two regions of index of refraction variation, at distances p_1 and p_2, are illustrated) and V is the propagation velocity of the wave.

The phase-detected output is coupled to an autocorrelator. While correlating with a time delay $2p_1/v$, the two copies of the modulation waveform produced by the index variation at p_1 coincide and produce an output pulse; the modulations produced by other sources (e.g., p_2) do not line up, and hence average to zero. Thus by sweeping the autocorrelator time delay from zero to the value $2R/v$, and averaging the output over a period of time, an output waveform similar to that shown will result, where the position of a pulse indicates the location, and the height of a pulse indicates the magnitude of the index of refraction variation encountered.

Notes:

1. The theoretical justification for this technique presented in the referenced report, considers a nonlinear wave equation derived to include time variation in addition to the usual spatial variations. The equation leads to a retarded-potential solution. The correlation-function results are extended to point out the Fresnel-zone weighting effect, which varies with the distance along the propagation path. The resolution of a source region is shown to be inversely proportional to its spectral bandwidth.
2. The following documentation may be obtained from:

Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.65)

Reference:
NASA-CR-95479 (N68-28656), Locating Refractive Index Variations with Bistatic-Radar

Patent status:

No patent action is contemplated by NASA.

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